Alberta Environment

SOUTH SASKATCHEWAN RIVER BASIN ADVISORY COMMITTEES

WATER MANAGEMENT MODELING INFORMATION PACKAGE

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BACKGROUND

The availability of water for consumptive and instream uses in the South Saskatchewan River Basin (SSRB) have been evaluated to assist in water management planning. The estimations of water availability were obtained through Alberta Environment's computer simulation tool, the Water Resources Management Model (WRMM).

It is important to establish a clear understanding of the water availability situation in the SSRB at this time, so further steps can be taken to strive for judicious and efficient management of water in the SSRB and to maximize the benefits that can be gained from this limited resource.

Computer simulations were completed for four water management scenarios, each of which represents different aspects of the existing water management situation.

WATER RESOURCES MANAGEMENT MODEL - GENERAL

Alberta Environment began development of the WRMM in 1979, for application in the SSRB Planning Program (1982-1985). It has subsequently been used in all substantive water management planning and operational studies in the South Saskatchewan and Milk River Basins.

The WRMM matches water supplies and demands in a river basin over a long-term time series. In the SSRB water supplies over the historical period 1928-1995 are matched on a weekly basis with demands. The model incorporates all infrastructure, present and committed in the SSRB.

Principal inputs to the model are:

- Historical climatic and river natural flow data (1928 – 1995);
- Irrigation district and private irrigation consumptive use and return;
- Non-irrigation withdrawals (municipal, industrial, and other projects);
- Instream objectives (fish habitat and water quality) (see definition);
- Reservoir and canal structure capacities and discharge limitations;
- Licence priorities, conditions and volume/rate limits;
- Operating policies for structures; and
- 1969 Apportionment Master Agreement (see definition).

For each scenario, results are calculated for all demands, structure storages and flows. The performance of the demand components is determined in terms of deficits; that is the frequency of deficits (inability to meet the component requirement due to insufficient water).

The main basis of the modeling is to allocate the available water supply to the various demands in order of licence priority and to make best use of storage structures to mitigate shortages in times of low water supply and high demands.

WATER ALLOCATION PRIORITIES

All major licences are represented according to their priorities and with their restrictions e.g., stage/flow and instream objective (IO) where applicable. It is not practical to individually model all licences in the SSRB because there are so many. Thus the smaller licences were compiled by river reach, into two categories: senior and junior. Categorization as senior or junior is based on licence date relative to introduction of IO's and construction of government on-stream storage.

On the Red Deer River, licences issued earlier than 1977, when Gleniffer Reservoir was licenced, are senior, since they must be satisfied before Gleniffer Reservoir can store water. Licences issued after 1977 are junior, since they receive water after Gleniffer. Gleniffer can fill as often as needed in order to maintain a recreation level and also to release water for IO's and apportionment. Any remaining water can, at the discretion of the Alberta Government, be released to supply junior licences, which cannot be completely satisfied from natural flow. However, reservoir operating rules must be followed in order to ensure enough water in the reservoir to meet priorities of recreation, IO and apportionment. Therefore, there are times when the additional water needed to supplement junior licences is not available to be released. Then the junior licences experience deficits.

An identical situation occurs in the Oldman mainstem where junior licences are designated as those issued after 1988, when the Oldman Reservoir was licenced.

On the Bow mainstem the only on-stream storage is licenced to Trans-Alta Utilities (TAU). A separate WRMM model of the Bow Basin above Bearspaw Reservoir was run to simulate TAU operations over the 1928-1995 period and to identify flow releases from Bearspaw Reservoir. The water availability analysis in this report assumes no change in TAU operations. Junior licences are defined as those licences which are subject to the 80% Fish Rule Curve (FRC) (see definition) which began to be applied in 1992.

The southern tributaries (Waterton, Belly and St. Mary Rivers) are also modeled separately from the main SSRB model and similarly to the TAU simulation, is an input to the main SSRB model. The Waterton-St Mary headworks system connects the three rivers and contains substantial Alberta Government storage, which is used to ensure that the consumptive licences are satisfied as much as possible. IO's are always met, but there is not sufficient water to make a significant contribution to apportionment in low flow years.

In all scenarios, Lake Gleniffer and the Oldman Reservoir are used to store and then release the flows needed to meet the requirements of the Alberta/Saskatchewan apportionment agreement.

CONSUMPTIVE DEMANDS

A Licenced Consumptive Demands

Consumptive demands are represented by licences that have been issued in the SSRB to date. The largest demands are from irrigation districts and private irrigation. Demands vary with climatic conditions for each year. These variable demands and return flows are computed by the Irrigation District Model (IDM) of Alberta Agriculture, Food and Rural Development (AAFRD). Scenarios of these demands for both current conditions and projected future use patterns within existing licences have been prepared by AAFRD.

An important parameter governing irrigation demands is the "irrigation practice", which is the response of irrigators to moisture deficit. Currently irrigators apply water at a level corresponding to 80% of moisture deficit. This is referred to as the evapotranspiration (ET) level, i.e., 80% ET is the current application practice. In future, AAFRD predicts that irrigators will apply more water, to a ceiling level of 90% of moisture deficit or the 90% ET level. 90% ET is considered to be the upper limit that irrigators will ever apply.

Non-irrigation demands are by comparison very small and generally modeled as non-varying from year to year.

More recent licences have instream objectives attached as conditions of withdrawal, and these are included in the modeling. Older licences generally have no instream objectives attached.

B Committed and Potential Projects (included in the WRMM)

- Little Bow Storage Project
  This is already licenced but not in place. Construction of the 50,000 acre-feet Little Bow River Reservoir, 60 cfs Clear Lake canal and expansion of the Little Bow canal to 300 cfs is under way. Applications for much of the 20,000 acres of irrigation associated with this project have been received;

- Carseland-Bow Headworks Expansion
  Main canal, Carseland to McGregor Reservoir – to 1,800 cfs
  Canal, McGregor Reservoir to Travers Reservoir – to 2,800 cfs
  Travers Reservoir to Little Bow Reservoir – to 3,100 cfs
  Little Bow Reservoir outlet – to 3,100 cfs

- Peigan First Nations Projects

- Siksika First Nations Projects

C Future Irrigation Demands

Are those quantities of water to irrigate the acreages specified in the 1991 SSRB Water Allocation Regulation (O.C. 615/91), that are currently not licenced. Future irrigation demands are divided into two categories:

- For irrigation districts, there are the volumes and/or rates, additional to those quantities in current licences that are needed to irrigate the acreages specified in the Regulation. Only Bow Basin districts are in this position. The Western and Bow River Irrigation Districts have submitted applications for additional volumes, the Eastern Irrigation District has submitted an application for additional rate; and

- For non-irrigation districts, these are the irrigated acres specified in the Regulation that are currently not licenced. In some cases applications have been received, but not yet authorized. For the remainder, no application has been received, e.g., the Special Areas Water Supply Project, which is listed in the Regulation as including 25,000 acres of irrigation.

D Future Non-Irrigation Demands

A consultant has estimated the potential non-irrigation demands in the SSRB for the years 2025 and 2050. However these demands have not been included in the modeling, except for:

- Two examples of industrial applications to predict their performance; and

- Year 2050 demands for the Highwood and Little Bow Basins are being used in the modeling for the Highwood Management Plan.

INSTREAM OBJECTIVES

Modeling scenarios were run using the existing IO's. These are flows which are attached to licences currently being issued.

A. Red Deer River Basin

On the mainstem reaches from Dickson Dam to the Saskatchewan border, the following IOs have been traditionally used:

- 300 cfs for irrigation licences; and
- 150 cfs for non-irrigation licences.

The aquatic eco-system protection achieved by these streamflows is unknown.

B. Bow River Basin

There are five mainstem reaches from Ghost Reservoir to Bassano Dam. These are:

- Ghost Reservoir outlet to Bearspaw Reservoir outlet;
- Bearspaw Reservoir outlet to Elbow River confluence;
- Elbow River confluence to Highwood River confluence;
- Highwood River confluence to Carseland weir; and
- Carseland weir to Bassano Dam.

Each reach has an IO which is the 80% habitat fish rule curve (80% FRC). There are no water quality protection IO flows.

The reach below Bassano to the mouth has three IOs:

- 1400 cfs for all licences except the Eastern Irrigation District (EID);
- 100 cfs for EID's 1963 licence; and
- 400 cfs for EID's 1998 application for increased rate.

The Highwood River has:

- no IO for private withdrawals;
- 1994 Operating Guidelines IO for Women's Coulee and existing Little Bow diversions (60 and 100 cfs respectively); and
- a future IO which provides protection for fish, water quality and flushing flows, applied to the Little Bow (300 cfs with canal expansion).

C. Oldman River Basin

There are six mainstem reaches from the Oldman Reservoir to the mouth. These are:

- Oldman Reservoir outlet to Pincher Creek confluence;
- Pincher Creek confluence to the Lethbridge Northern Irrigation District (LNID) weir;
- LNID weir to Willow Creek confluence;
- Willow Creek confluence to Belly River confluence;
- Belly River confluence to St Mary River confluence; and
- St Mary River confluence to the mouth of the Oldman River.

Like the mainstem reaches on the Bow, each reach has an IO which is the 80% FRC. However, unlike the Bow each reach also has water quality protection flows.

The three southern tributaries to the Oldman River each have minimum flows specified in the SSRB Regulation. These flows were modeled as IO's:

- 80 cfs for the Waterton River at the mouth;
- 33 cfs for the Belly River below the Waterton-St. Mary Headworks canal; and
- 97 cfs for the St. Mary River at the mouth.

The aquatic environment protection obtained from these IOs is not known. However, they have been characterized as "hardship flows" in the 1978 Oldman River Final Report and Recommendations.

The Willow Creek IO is 14/28 cfs in the summer and 10/15 cfs in the winter.

D. South Saskatchewan River sub-basin

From the confluence of the Bow and Oldman Rivers to the Saskatchewan border an IO of 1500 cfs is attached to licences.

SCENARIOS DESCRIPTION

Four scenarios were chosen to scope the water availability within the SSRB. All scenarios model the Alberta/Saskatchewan Apportionment Agreement. The four scenarios are:

A. Existing Licences and Commitments Scenario

This scenario models:

Existing licences with full annual use of non-irrigation licences, variable use of all irrigation licences, subject to their specified instream objectives. One industrial application is included.

- Irrigation districts at SSRB Regulation acreage limits and 90% ET irrigation practice as determined by AAFRD;
- Carseland-Bow Headworks enlargements and Preliminary Operating Strategy October 2001;
- Little Bow Storage Project supplying 20,000 acres of new irrigation;
- Peigan First Nations Projects; and
- Siksika First Nations Projects .

B Maximum Scenario

Same as Scenario A, but:

- All licences used to the maximum every year, regardless of climatic conditions; and
- No return flows from irrigation districts.

Scenario B presents an extreme view of all licence-holders calling upon their licences to the full extent every year, regardless of climatic conditions. Additional storage, assumption of greater levels of risk, and/or other changes in management (e.g., "pump-back" systems) would be needed for Scenario B to occur.

C. SSRB Regulation Potential Scenario

Same as Scenario A, plus:

- Irrigation district applications (WID: 117,600 at acre-feet, BRID: at 52,000 and 37,300 acre-feet, EID: at 3,400 cfs);
- All non-irrigation district irrigation applications and projections to the SSRB Regulation acreage limits (e.g., Special Areas Water Supply Project at 25,000 acres);
- Non-irrigation demands for the Highwood and Little Bow basins to the year 2050; and
- An industrial application (5,000 acre-feet at 10 cfs over the March 1 to October 31 period).

D. SSRB Regulation 20% Expansion Scenario

Same as Scenario C, but:

- Irrigation district areas increased to 120% of the SSRB Regulation acreage limits plus a future variation in crops and irrigation method.

Scenario C illustrates the water availability situation if irrigation district volume/rate applications and private irrigation applications are issued up to the limit of the SSRB Regulation, and irrigation practice reaches the 90% ET level. Irrigation districts are modeled at the SSRB Regulation acreage limits.

Scenario D models a similar situation, but with irrigation district acreages at 120% of the SSRB Regulation limits. This requires a larger volume of water, but is still within the quantity of existing licences and the applications that have been received (as in Scenario C, above).

In both scenarios the industrial applications were modeled to see the expected deficits of future applications. These deficits are indicative of the risks of obtaining new licences rather than seeking a more secure supply under the Water Act transfer mechanism.

Unlike the situations represented in scenarios A and B, these two scenarios (C and D) are speculative since the Alberta Government is not obliged to issue licences for the applications.

MODELING RESULTS

The scenario results are presented in tables on the following pages. There is one table for each sub-basin which summarizes the number of years out of 68 (1928-1995) that deficits occur. Deficit years are extracted from the analysis for the following demand categories:

- Irrigation districts;
- Non-irrigation district junior licences (senior licences do not deficit)
    - Private irrigation
    - Non-irrigation
- Instream objectives;
- Future private irrigation (to SSRB Regulation limit);
- Peigan and Siksika First Nations Projects;
- Industrial projects

For irrigation, a deficit is defined as a year in which the annual shortfall in water supply is in excess of 50mm. For ID's, the shortfall is against the block demand for the year and for private irrigation the shortfall is against the licenced volume or expected licenced volume.

For non-irrigation demands, deficit year is defined as a year when the deficit is in excess of 5% of the licenced volume or expected licenced volume.

For instream objectives, a deficit year is defined as a year in which the instream flow is less than the IO flow for two or more weeks.

Apportionment performance is summarized as follows:

- For all four scenarios the instantaneous apportionment requirement is always met.

- For Scenarios A, C and D the annual apportionment requirement is always met; however, in Scenario B the annual apportionment requirement is not met in 14 out of 68 years. The worst years are 1937 and 1985, in which only 45% of annual volume could be delivered to Saskatchewan.

Although the Highwood/Little Bow Basins are included in the modeling analysis, the results for their demands are not included in this report. This is because development of the Highwood Management Plan is underway.

The Special Areas Water Supply Project (SAWSP) is represented in a separate WRMM simulation. It is proposed to withdraw water from the Red Deer River near Nevis and to supply this to Sounding and Berry Creeks for irrigation and waterfowl (Ducks Unlimited) uses. The model was run over the 1928-1995 period and the demands input to the main SSRB model. The results presented are for the overall SAWSP demand, rather than for individual irrigation or wildfowl projects.

SCENARIO RESULTS – RED DEER RIVER BASIN

Number of deficit years out of 68 (1928-1995 Period)

	Scenario A	Scenario B	Scenario C	Scenario D
Junior Licences (Private Irrigation)	0	10	1	4
Junior Licences (Non-Irrigation)	0	22	3	7
IOs below Gleniffer	0	0	0	0
IOs below Red Deer	0	6	0	0
Future Irrigation (SSRB Regulation)	N/A	N/A	6	7
Special Areas Project	N/A	N/A	8	9

Notes:

1. Junior private irrigation and non-irrigation Licences—post 1977 (Dickson Dam licence).
2. IO's are 300 cfs during the irrigation season and 150 cfs during the non-irrigation season.

Summary of Scenario Descriptions

Scenario A	Existing licences and commitments. Irrigation district areas at SSRB Regulation limits and irrigation practice at future ceiling of 90% ET.
Scenario B	Maximum demand each year for existing licences and commitments. No return flows from irrigation districts.
Scenario C	Same as Scenario A plus irrigation volumes and areas up to the SSRB Regulation limits.
Scenario D	Same as Scenario C plus 20% increase in irrigation districts areas which would exceed the SSRB Regulation limits but not exceed the original projected allocated volume of water.

SCENARIO RESULTS – BOW RIVER BASIN

Number of deficit years out of 68 (1928-1995 Period)

	Scenario A	Scenario B	Scenario C	Scenario D
Western Irrigation District	46	0	19	24
Bow River Irrigation District	0	0	0	0
Eastern Irrigation District	0	0	1	3
Junior Licences (Private Irrigation)	16-26	16-52	16-26	16-32
Junior Licences (Non-Irrigation)	16-26	16-52	16-26	16-32
IOs upstream of Carseland	16	16	16	16
IOs downstream of Carseland	26	52	26	32
Future Irrigation (SSRB Regulation)	N/A	N/A	37	46
Siksika Irrigation Project	17	19	17	20
Industry	17	28	33	42
Industry	N/A	N/A	45	50

Notes:

1. Junior private irrigation and non-irrigation licences—post 1982 (80% FRC).
2. Instream objectives are 80% FRC from Ghost Dam to Bassano Reservoir.
3. In Scenarios C and D the Eastern Irrigation District is credited with a 1998 priority licence to enable withdrawals up to 3,400 cfs provided that a IO of 400 cfs below Bassano is always satisfied.

   Western and Bow River Irrigation Districts applications are modeled as subject to 80% FRC.

Summary of Scenario Descriptions

Scenario A	Existing licences and commitments. Irrigation district areas at SSRB Regulation limits and irrigation practice at future ceiling of 90% ET.
Scenario B	Maximum demand each year for existing licences and commitments. No return flows from irrigation districts.
Scenario C	Same as Scenario A plus irrigation volumes and areas up to the SSRB Regulation limits.
Scenario D	Same as Scenario C plus 20% increase in irrigation districts areas which would exceed the SSRB Regulation limits but not exceed the original projected allocated volume of water.

SCENARIO RESULTS – OLDMAN RIVER BASIN

Number of deficit years out of 68 (1928-1995 Period)

	Scenario A	Scenario B	Scenario C	Scenario D
OLDMAN MAINSTEM				
Lethbridge Northern Irrigation District	6	59	7	11
Junior Licences (Private Irrigation)	6	59	7	11
Junior Licences (Non-Irrigation)	8	61	9	13
IOs (Oldman Dam – mouth)	0	2	0	0
Future Irrigation (SSRB Regulation)	N/A	N/A	12	22
Peigan Irrigation Project	2	67	2	4
Keho Barons South Irrigation Project	N/A	N/A	16	27
WILLOW CREEK				
Junior Licences (Irrigation U/S Pine Coulee)	59	60	59	59
Junior Licences (Irrigation D/S Pine Coulee)	10	16	36	36
Future Irrigation (Off and D/S Pine Coulee)	N/A	N/A	36	36
IOs (Pine Coulee – mouth)	0	0	0	0
SOUTHERN TRIBUTARIES				
St. Mary River Irrigation District	4	N/A	4	11
Taber Irrigation District	6	N/A	6	10
Raymond Irrigation District	4	N/A	4	6
Magrath Irrigation District	4	N/A	4	6
United Irrigation District	1	N/A	1	1
Mountain View, Leavitt and Aetna Irrigation Districts	3	N/A	3	3
Blood Tribe Irrigation Project	1	N/A	1	5

SCENARIO RESULTS – OLDMAN RIVER BASIN (Continued...)

Notes:

1. Junior licences:

   Oldman mainstem – post 1988 (Oldman Dam licence);
   Southern tributaries – post 1950 (Waterton-St Mary Headworks licence); and
   Willow Creek – post 1944 (Chain Lakes licence).

2. Instream objectives are:

   - Oldman Dam to mouth: 80% FRC plus water quality minimum flows;
   - Lower Waterton River: 80 cfs;
   - Lower Belly River: 33 cfs;
   - Lower St. Mary River: 97 cfs; and
   - Willow Creek: 14/28 cfs summer; 10/15 cfs winter.

Summary of Scenario Descriptions

Scenario A	Existing licences and commitments. Irrigation district areas at SSRB Regulation limits and irrigation practice at future ceiling of 90% ET.
Scenario B	Maximum demand each year for existing licences and commitments. No return flows from irrigation districts.
Scenario C	Same as Scenario A plus irrigation volumes and areas up to the SSRB Regulation limits.
Scenario D	Same as Scenario C plus 20% increase in irrigation districts areas which would exceed the SSRB Regulation limits but not exceed the original projected allocated volume of water.

SCENARIO RESULTS - SOUTH SASKATCHEWAN SUB-BASIN

Number of deficit years out of 68 (1928-1995 Period)

	Scenario A	Scenario B	Scenario C	Scenario D
Junior Licences (Private Irrigation)	5	57	7	10
Junior Licences (Non-Irrigation)	7	59	9	12
IOs	0	1	0	0
Future Irrigation (SSRB Regulation)	N/A	N/A	10	20

Notes:

1. Junior private irrigation and non-irrigation licences—post 1988 (Oldman Dam licence).
2. Instream objectives flow is 1500 cfs (instantaneous apportionment requirement).

Summary of Scenario Descriptions

Scenario A	Existing licences and commitments. Irrigation district areas at SSRB Regulation limits and irrigation practice at future ceiling of 90% ET.
Scenario B	Maximum demand each year for existing licences and commitments. No return flows from irrigation districts.
Scenario C	Same as Scenario A plus irrigation volumes and areas up to the SSRB Regulation limits.
Scenario D	Same as Scenario C plus 20% increase in irrigation districts areas which would exceed the SSRB Regulation limits but not exceed the original projected allocated volume of water.

SCENARIO EVALUATIONS

A. Maximum Scenario (B)

This scenario describes the impact of all licences attempting to divert their total allocation every year. This reduces the quantity of water that can be stored and carried over to the next year in both on-stream and off-stream reservoirs. The consequence is that reduced storage is available to meet apportionment and instream objectives. Even though all Alberta Government storage was dedicated in this scenario to meeting these demands there was still insufficient water. Thus, in 14 years the 50% of natural flow that Alberta is contractually obliged to pass to Saskatchewan could not be passed. The lowest percentage volume was 45% in two years. Additionally, there were some deficits to instream objectives and many deficits to junior licences.

B. Scenarios A, C and D

i) Red Deer Basin

The results of these scenarios show that existing licences and commitments can be met and that future expansion (e.g., SSRB Regulation-limited private irrigation, including the Special Areas project) is possible. However, it should be remembered that in the modeling, the only instream restriction on future projects was the current IO values (300 cfs, May to September and 150 cfs, October to April).

The IO values are somewhat arbitrary and have no scientific justification in terms of aquatic ecosystem protection. New IO's will be established with scientifically determined instream needs and are likely to have higher values. Offsetting this however, is the requirement to release sufficient water from Dickson Dam to maintain a flow of 565 cfs to Red Deer. This was also included in the modeling.

Until new IO's are determined for the Red Deer River the future expansion potential is not able to be defined.

ii) Bow Basin

Eastern Irrigation District

The EID is able to sustain irrigation at the future 90% ET (moisture deficit or evapotrapiration) level for acreages up to the SSRB Regulation limits (Scenarios A and C). Scenario A utilizes only the existing 1903 priority licence, so the flow below Bassano falls occasionally to 100 cfs. Scenario C models the same district demand, but utilizes an additional licence (1998 priority, expected to be issued shortly) to achieve the same success level as Scenario A, but with flows below Bassano maintained at a 400 cfs minimum value. Scenario D increases the Scenario C acreages to 120% of the Regulation limit and indicates that this is also viable, provided that significant improvements in efficiency and return flow are made.

Bow River Irrigation District

This district is in a similar position to the EID. The analysis indicates that with an 1800 cfs canal, BRID can irrigate its SSRB Regulation limit acreage with its existing licences.

Western Irrigation District

The WID is presently irrigating up to 68,000 acres under its 1903 licence of 160,400 acre-feet, and with a Temporary Diversion Licence (TDL). The TDL permits withdrawal from the Bow river in excess of the 1903 licence stage/diversion limits up to 1000 cfs, subject to meeting the 80%FRC in the Bow river below the Western Headworks.

Scenario A confirms that the 1903 licence alone i.e. without a TDL, is inadequate to irrigate its SSRB Regulation acreage limit (95,000 acres) at the 90% ET level with future efficiencies. For the same demand, Scenario C shows 19 deficit years, even if the current licence application for 117,600 acre-feet is granted. This is principally because its 2000 priority is junior to both the BRID and the EID applications. Particularly, the present EID application for an increase in withdrawal rate would result in flows below Bassano being more frequently at 400 cfs (the proposed IO).

Non-Irrigation District Demands

Future licences would have substantial numbers of deficit years in supply and also in IO flows that these future licences would be subject to. In particular it appears that the Siksika irrigation project may need some storage. The performance of the industrial projects also show many years with deficits. Any future developments that require significant volume will likely require storage.

iii) Oldman Basin/South Saskatchewan Sub-basin

The modeling of consumptive demands in the Oldman mainstem/South Saskatchewan sub-basin is influenced by substantial Alberta Government storage (Oldman Dam, Waterton and St. Mary Reservoirs). Storage is used to supplement consumptive licences, after meeting instream objectives and apportionment. The St. Mary project and the Lethbridge Northern Irrigation District have licences senior to government storage and IO's. However, they were issued additional licences in 1992 for volumes that enabled them to irrigate up to the SSRB Regulation acreage limits. These later licences are junior to government storage and are subject to IOs. Junior licences on the Oldman mainstem/South Saskatchewan sub-basin are those after 1988 which is the priority of the Oldman Dam.

For the entire basin (Oldman mainstem/South Saskatchewan sub-basin, southern tributaries and Willow Creek), irrigation demands at SSRB Regulation acreage limits are a high proportion of the natural flow. The additional diversions needed to meet demands are provided from government storage that remains after meeting IOs and apportionment.

Lethbridge Northern Irrigation District

In the LNID, Scenarios A and C are the same because the district already has licences for the acre-feet that were estimated in 1992 as being required to irrigate its SSRB limit acreage of 167,000 acres. Thus the district, which currently irrigates approximately 150,000 acres, should be able to move to the 90% ET level of irrigation practice at SSRB Regulation acreage limits.

Scenario D indicates that further expansion to 120% of SSRB Regulation acreage increases the risk to junior licences.

Willow Creek

In the Willow Creek Basin IOs show no deficits, because the model adopts the current policy of operating Chain Lakes (1944 priority) and Pine Coulee Reservoir (1994 priority) to maintain instream protection.

If future irrigation licences are issued these will depend on and will share Pine Coulee storage with existing juniors. The poor performance of future licences and that of existing juniors (Scenarios C, D) indicates that Pine Coulee storage cannot support any significant increase in demand while maintaining downstream IO's.

Southern Tributaries

The government headworks in the southern tributaries has a priority of 1950, which enables a simplified modeling approach. It guarantees IO's and assigns the remaining water to consumptive demands, following an "equal deficit" policy for storage in the headworks system. Irrigation levels of 90% ET up to the SSRB Regulation acreage limits appear to be supportable (Scenarios A, C), but additional district expansion (Scenario D) has more risk.

iv) Bow, Oldman Mainstem/South Saskatchewan Sub-basin Summary

Generally, the analysis shows that if new licences would be issued, the junior water rights will be of limited value to the licence-holder. The only security of supply for future essential development would be through the transfer system of the Water Act.

The above discussion must be qualified in that further calibration of the AAFRD Irrigation Resources Model for BRID, LNID and WID is needed in order to confirm WRMM results for these districts. In addition, results for all three districts are sensitive to the future efficiencies assumed by AAFRD.

DEFINITIONS

Instream Need (IN)	This is a scientifically determined amount of water, flow rate or water level that is required to sustain the aquatic environment in a healthy condition. Instream needs can also be determined for River recreation or other purposes, such as aesthetics. An instream need is not necessarily the same as the natural flow. At some times of the year (i.e. during high flows), for some components of the aquatic environment, the instream need can be less than the natural flow, while at other times of the year (i.e. during low flows) the instream need can be quite close to (if not the same as) the natural flow. In some circumstances, the instream need may be greater than the natural flow (e.g., when it is necessary to dilute waste). For purposes of the SSRB Water Management Plan, the aquatic environment is considered to be represented by: fish habitat, riparian vegetation (primarily the poplar forests on the flood plain), water quality (for fish), and channel structure. This latter term refers to stream erosion processes that serve to establish and maintain natural habitats.
Instream Objective (IO)	This term is presently in use to describe a desired flow level that has been established through public consultation, and is a target for water management. Given current knowledge and tools, IO 's have usually been set in response to fish habitat instream needs (the Fish Rule Curve). Many of the existing instream objectives are set at 80% of the Fish Rule Curve. IO's are included as a condition in more recent licences (that is, water cannot be withdrawn if the actual River flow is at or below the IO). It is anticipated that the term "instream objective" will eventually be superceded by the term "water conservation objective."
Water Conservation Objective (WCO)	From the Water Act: a *"water conservation objective" means the amount and quality of water established by the Director under Part 2, based on information available to the Director, to be necessary for the* *(i) protection of a natural water body or its aquatic environment, or any part of them,* *(ii) protection of tourism, recreational, transportation or waste assimilation uses of water, or* *(iii) management of fish or wildlife,* *and may include water necessary for the rate of flow of water or water level requirements.* This is an amount of water flow that is agreed upon through planning processes, during which the demands for consumptive use are compared with the instream needs and society then makes a choice about how much water should be in the River for the aquatic environment. In some cases, the water conservation objective could be the same as an instream need and/or the natural flow. In other cases, a water conservation objective can be selected that compromises between instream needs and consumptive demands. A water conservation objective can also be a target, and water could be obtained through transfers and water conservation holdbacks to eventually achieve and stay on this target.

Master Agreement on Apportionment	*Schedule A of the 1969 Master Agreement on Apportionment for the South Saskatchewan River between Alberta and Saskatchewan, specifies that:* - annually, one half of the natural flow of the SSRB shall be passed to Saskatchewan. However if natural flow falls below 4.2 million acre-feet, Alberta can still keep more than half of the natural flow to a maximum quantity of 2.1 million acre-feet, provided that the instantaneous flow does not fall below 1,500 cfs (see clause below); - instantaneously, the combined flow of the South Saskatchewan and Red Deer Rivers into Saskatchewan shall be not less than 1,500 cubic feet per second or half of the instantaneous natural flow, whichever is less.
Fish Rule Curve	A FRC is a flow recommended to provide protection to the aquatic environment. It is based upon habitat modeling for a few selected life stages of sportfish species. The 80% FRC represents a 20% reduction in habitat from the original FRC for flows that can be expected to occur between 21 and 79 percent of the time.